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NEW HAMPSHIRE COLLEGE
AGRICULTURAL EXPERIMENT STATION

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BY CLARENCE M. WEED

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OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM, N. H.

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SOME DANGEROUS FRUIT INSECTS

BY CLARENCE M. WEED

None of the evil effects of the changes which modern civilization has made upon the earth is more evident to the American farmer than the increased difficulty of saving his crops from the ravages of noxious insects and parasitic fungi. Many of us have heard from our fathers and grandfathers of the apples which once grew in abundance in yards and along highways, strangers alike to the codling moth, maggot, or scab, the luscious peaches free from worms and rot, the plums unmarked by the curculio, and the pears that had yet to learn the secret of becoming dwarfed, gnarly, and cracked; of the grapes that knew not how to rot, and the potatoes which had neither been blighted nor bitten by the Colorado beetle. Now all is changed: every crop has foes that often gather the lion's share of the harvest. The enemies have come from the north and the south, the east and the west, from Europe and the islands of the sea, and in our own midst they have flocked from the forest to the field, deserting a wild plant for its cultivated congener, or changing their habits to conform to a new environment.

This increase of noxious insects, however, is the natural result of the changed conditions of things. Among the principal factors tending toward it, may be mentioned: (1) the massing of crops in limited areas; (2) the facilities for transporting insects long distances by vessels and railways carrying agricultural products; (3) the abandoned farms and orchards that serve as breeding grounds; and (4) the destruction of forests and the cultivation of prairies.

Considering each of these factors briefly, we find that the tendency of the first—that of the massing of crops in limited

areas—toward increasing our insect pests rests upon the biological law that the increase of any animal is limited by its food-supply. Under the natural conditions existing on this continent before the advent of the white man, those insects which fed on wild plants had, as a rule, only a limited food-supply. The apple maggot, or railroad worm, for example, is supposed to have bred originally in the wild haws of the woods. The parent flies had then usually to find here and there an isolated tree bearing the fruit in which it deposited its eggs. Its chances of being caught by a bird or entrapped in a spider's web while on this search were very good, so that the scarcity of the food-supply not only directly limited the number of individuals that could be produced, but by being scattered it increased the chances of the adult insects falling a prey to enemies. But in a modern apple orchard all this is changed: the food-supply is almost unlimited, and is so massed together that the insect runs little risk in passing from fruit to fruit, or from tree to tree. Hence it can multiply indefinitely, unless there is some means of checking it. The same line of reasoning applies to a large proportion of our injurious insects.

We are indebted to our commerce on sea and land for many of the most noxious insects. Brought to our shores from Europe, Asia, or Australia by ships, many of these pests have found a land which for them was flowing with milk and honey, and in which their hereditary enemies had not yet gained a foothold. Consequently they have multiplied without let or hindrance; and by natural and artificial means—notably the railroad trains—they have rapidly overrun the country of their adoption.

The abandoned or neglected fields and orchards all over the United States have proven a prolific breeding ground for many insect pests. Too often the efforts of painstaking farmers have been rendered unavailing by the proximity of such sources of infection. An orchard that has outlived its usefulness had better be converted into firewood than left to die uncared for.

The destruction of forests has compelled certain insects to resort to cultivated crops for subsistence; and in some cases a decided change in feeding habits has resulted. So, also, the bringing of the prairies into cultivation has caused many insects

which originally fed on wild grasses, to resort to pastures and meadow lands.

The operation of these various causes, together with the enormous powers of multiplication possessed by the insects themselves, has led to a constantly increasing injury to cultivated crops, until to-day these tiny foes exact a tribute of ten per cent. of the crop products of American agriculture. They form an omnipresent host of taxgatherers, taking possession of the farmer's crops and enforcing their onerous demands without process of law, unless preventive measures are vigorously prosecuted. They are no respecters of persons; like the rain, they fall upon the fields of both the just and the unjust.

"The authorities best able to judge have estimated the annual loss in the United States due to these little pests at nearly half a billion dollars. Noxious insects, according to Dr. C. V. Riley, recently the distinguished entomologist of our National Department of Agriculture, occasion losses in the United States which are 'in the aggregate enormous, and have been variously estimated at from $300,000,000 to $400,000,000 annually.' In single states and single seasons the loss is often frightful in extent. During some of the great chinch-bug epidemics the loss in Illinois occasioned by this one insect has amounted to over $73,000,000 a year; and in seasons not marked by an outbreak of such a great crop pest the injury is much more severe than is ordinarily supposed. The official entomologist of the state just named, Professor S. A. Forbes—after years of careful field observation and statistical study—has recently expressed his belief that 'the insects of the state of Illinois derive as large a profit from the agriculture of this great agricultural state as do the farmers themselves.'" *

Fortunately, however, there is an extended silver lining to this dark cloud of insect injury. If these creatures have increased on every hand, our knowledge of methods of controlling them has also augmented with the passing years. Many of the remedies proposed ten or twenty years ago, seem now foolish and impracticable. Within the last decade especially, the progress has been phenomenal. It has been shown that many

* C. M. Weed, Popular Science Monthly, March, 1893.

insects can be checkmated by a proper crop rotation; that the natural enemies of others can be used to destroy them; and that others are easily killed by improved insecticides. But the most important advance has been the introduction of the spraying machine, an apparatus by means of which insect killing substances may be easily and rapidly distributed over the surfaces of trees, shrubs, vines, and herbaceous plants. As I have elsewhere said, its introduction into American horticulture marks an advance almost as important as was marked by the advent of the improved cultivators into our agriculture. Before the latter were introduced the weeds that infest the soil were fought by the hand hoe, but now a single team does the work of many men. In the same way until recently various laborious and partially effective methods were used in fighting noxious insects and destructive fungi; but now many foes of both these classes are fought on a large scale by the force-pump and spray nozzle, and every season adds others to the list of those against which this method may be successfully used. With a large class of farmers and fruit growers, spraying has become a recognized part of the season's operations, and therein lies the chief promise of the method. When the belief becomes general that it is as important to save a crop from destruction by its foes as it is to produce it; that fighting noxious worms must take its place as a farm process by the side of that of fighting noxious weeds; that the parasitic plants which absorb the vitality of leaf and fruit are as dangerous to the crop as the plants which dispute with it the possession of the soil—and when along with this recognition there is placed before the farming community a cheap and wholesale method of preventing the injuries of these organisms, then the vast annual loss now suffered because of insects and fungi will be very greatly lessened.

The introduction of destructive insects still continues and is likely to continue for many years to come. At present there are two recently introduced insects that have not yet appeared in New Hampshire so far as known, but which are liable to reach us at any time and to become very destructive. I refer to the Gypsy Moth and the San José Scale. There are three other insects—the Pear Midge, Pear Tree Psylla, and Bud

Worm—which are probably present in some parts of the state, but which have not yet become so injurious as they have in neighboring states. The purpose of these pages is to warn the fruit-growers of the state of the threatened danger, and to give them the information necessary for recognizing and combating the pests when they do appear. For the facts I am especially indebted to the publications of the Department of Agriculture, the State Entomologist of New York, and the experiment stations of New Jersey and the Cornell University. The illustrations have come from the same sources, and should be specifically credited as follows: After Slingerland, Figs. 3–8; after Howard, Figs. 10–14; after Taschenburg, Figs. 15–18; after Lintner, Fig. 1; after Riley, Fig. 2.

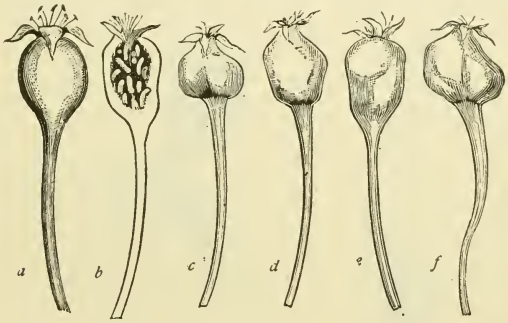

FIG. 1. Pear Midge Injury: *a*, uninjured young pear; *b*, infested pear cut open to show midge larvæ; *c*, *d*, *e*, *f*, outlines of infested fruits.

The Pear Midge

Diplosis pyrivora

This insect appears to have been introduced into America about 1877, being first noticed in Connecticut. It has since spread into a number of neighboring states, and has become in many localities the most destructive enemy of the pear. The adult is a small mosquito-like grayish fly (Fig. 2, *c*) having a slender body, long legs, and a long ovipositor project-

ing from the end of the abdomen. These flies appear in the pear orchard in early spring, even before the blossoms open, and continue present about ten days. As soon as the blossoms open sufficiently for the insect to insert its ovipositor, the eggs —often nearly a dozen in number—are deposited inside the blossom envelopes. Three or four days later the eggs hatch into little maggots which enter the open ovary of the embryo fruit, where they feed upon the growing tissues, gnawing and rasping it in such a manner as to destroy the core and seeds, and cause the fruits to become dwarfed and deformed. Such pears are ill-shapen in outer appearance, as shown in the series represented in Fig. 1. The midge maggots at first are whitish in color, but they soon become orange or reddish. They become full-grown early in summer: they are then "about one-

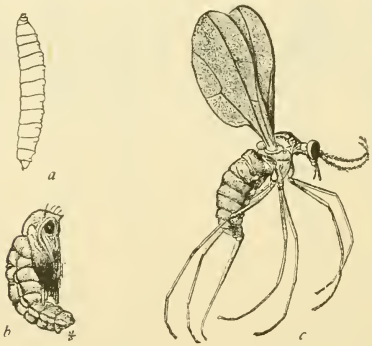

FIG. 2. Pear Midge: *a*, larva; *b*, pupa; *c*, parent fly. Magnified.

sixth of an inch in length, pointed towards each extremity, yellow in color, with a brown, horny breast bone on the under side just behind the head. The segments of the body are well-marked, and when removed from the infested fruit they move about quite rapidly, bending themselves quite double by drawing the tail forward until it touches the head, and then jerking or springing upward and outward several inches at a time.

When they are full grown they remain in the fruit until there comes a rain, which causes a rapid decay and a cracking open of the infested fruit. Through the openings so made they emerge and drop to the ground."* They then enter the soil an inch or two where somewhat later they make oval cocoons of silk mixed with particles of earth or sand: in these cocoons they apparently remain unchanged until the following spring when they become pupæ and shortly afterwards again change to adult flies.

These midges appear to have decided preferences among varieties of pears, the Lawrence being the favorite.

Remedies.—The only stage at which this insect is liable to injury without detriment to the trees is when the larvæ are in the ground. Professor J. B. Smith of New Jersey has found that they then can be destroyed to advantage by the application of kainit applied about the middle of June to the ground beneath the trees at the rate of 1,000 pounds to the acre. This is dissolved by the soil moisture and causes the death of the naked midge larvæ. In case an orchard is generally infested Professor Smith recommends the following practice: "Cultivate as usual, or, if the orchard is in grass or clover, plow under after June 15th, as soon as may be. Top-dress with kainit, 1,000 pounds to the acre, to benefit trees as well as to kill insects. As soon as proper, say early in August, sow crimson clover. This will use up the potash not required by the fruit trees, and will store nitrogen, as well as occupy the ground. Early in the following spring turn this sod under as deeply as may be proper. It should be done before the pear buds are developed, in order to head off and destroy any midges then in the pupa state near the surface of the soil."

The Pear-tree Psylla

Psylla pyricola

This is an extremely minute insect, which during recent years has done great damage to pear orchards in several eastern

* J. B. Smith.

states. It was apparently introduced into Connecticut early in the present century; since then it has spread west to Ohio, Michigan, and Illinois, south to New York and New Jersey, and probably over much of New England, though here it has been reported as destructive only in Massachusetts and Connecticut.

Fig. 3. Pear Psylla. Magnified.

The adult pear psylla is a small, jumping louse about one tenth of an inch long, resembling, when magnified, Fig. 3. It has four nearly transparent wings, and is reddish with transverse dark stripes on the abdomen. There are two distinct forms. The summer broods are much lighter in color than the brood which passes through the winter. This difference is so great that the two forms were considered distinct species until the life history was carefully worked out by Mr. M. V. Slingerland.

The dark form passes through the winter in some sheltered situation about the tree, such as beneath loose bark, or in the crevices between the branches. In early spring they come forth from their hiding places and deposit their eggs about the buds and on rough bark. These eggs are very small, and of the extraordinary form represented in Fig. 4. When first deposited they are yellowish, but turn dark soon afterwards. The eggs hatch in three or four weeks, the time depending largely on weather conditions. The young psyllas, which during their immature stages are called nymphs, crawl to the stalks of the unfolding leaves, in which they insert their tiny beaks to suck out the sap. They grow rapidly, occasionally moulting or shedding their skins to provide for their increase in size, and in the course of a month become mature.

The first summer brood thus developed deposits eggs on the under sides of the leaves. These eggs hatch ten days later, and mature in about three weeks. The insects of the second brood suck the sap from the leaves. There are several of these summer broods, the number varying with the

Fig. 4. Egg. Magnified.

locality and length of season. In early autumn the dark, hibernating winter form is developed.

The sap which passes through the bodies of these little creatures is ejected on the foliage, and forms the so-called "honey dew." Where the insects are very numerous this becomes very abundant, falling in showers when the branches are disturbed. After the honey dew has been present for some time a peculiar black fungus develops upon it, and gives the tree a sooty appearance.

Mr. Slingerland makes the following statement concerning the indications of the presence of the pest: "Among the first indications that pear growers, who suffered from this pest in 1891, had of its presence, was the noticeably lessened vitality of their trees early in the season. Old trees, especially, put forth but little new growth. Where new growth started, in many cases the shoots began to droop and wither in May, as if from a loss of sap. A little later, whole trees put on a sickly appearance; the leaves turned yellow and the fruit grew but little. By midsummer nearly all the leaves and half-formed fruit fell from many trees."

Remedies.—This insect can be destroyed by spraying in spring after the eggs hatch out and before the first brood matures, with kerosene emulsion diluted with twenty-five parts of water. This is a simple and satisfactory remedy; if applied soon after a shower has washed off much of the honey dew it is more effective.

The Bud-worm

Tmetocera ocellana

There is evidence to show that this insect was introduced to America from Europe early in the present century. It now occurs over a large portion of Canada and the United States, and sometimes is very destructive over wide areas, occasionally becoming the most serious orchard pest of the season. As soon in spring as the buds begin to open, the little caterpillars may commence work upon them, gnawing the miniature leaves and blossoms, but the attack is more likely to begin after the

buds about half open. The larvæ then eat out the centres of the buds, where the leaves and flowers are least developed. The caterpillar forms for itself a protecting case by using silken threads to bind together the leaves. As the season advances some of the leaves are killed, become detached at the base, and turn brown; the blossoms also are more or less webbed, so that the smaller branches present an appearance similar to the accompanying illustration. (Fig. 6.)

The life-history of this insect may be summarized as follows: The moths appear in the orchard early in summer; during daylight they rest upon the bark of trees or other shelter; at night they fly about and deposit their eggs, one in a place on the under side of the leaves. About ten days later these eggs hatch into small green larvæ, which feed upon the epidermis of the leaves, each making for itself a silken tube and a thin layer of silk for protection and concealment. In a day or two the green color changes to brown.

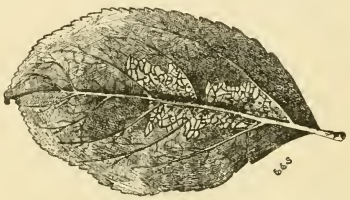

FIG. 5. Apple leaf showing work of young bud-worm.

"As the larva increases in size and the area over which it feeds becomes larger, the tube is enlarged and lengthened along the midrib, sometimes becoming nearly one inch in length. The silken web under which the larva feeds covers the entire field of operations, but is so thin near the edges where the larva has last fed as to be scarcely visible. The excrement of the larva being retained by the web appears as little black pellets scattered here and there over the feeding ground."*

The green portion of only one side of the leaf is eaten, the veins and veinlets being left untouched: these and the green of the opposite side die and turn brown, and thus become conspicuous.

* M. V. Slingerland.

FIG. 6. Work of bud-worm among opening leaves.

Late in summer or early in autumn the half-grown caterpillars desert the leaves and crawl upon the twigs, where they form little silken cases, generally near the buds or in creases in the bark. (Fig. 7.) In these they remain throughout the winter. The following spring they emerge to feed upon the opening leaves. They again make tubes, which serve as protective cases. After feeding six or seven weeks they become full-grown: then they form silken cocoons, generally in a rolled leaf or between two leaves, in which they change to pupæ, to emerge a short time later as moths.

The full-grown larvæ are cinnamon brown in color with the head, legs, and shield behind dead black. They are about half an inch long and of the general form shown in Fig. 8, *c*.

FIG. 7. Twig showing the position of the winter homes of the larvæ at *a*, *a*, and *b*, natural size.

The moth Fig. 9, has a general resemblance to the common codling moth. It is dark ashen gray with creamy white blotches on the front wings, which expand a little more than half an inch.

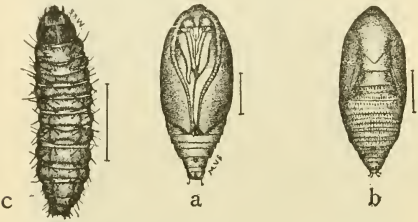

FIG. 8. Bud-worm: *a*, pupa, front view; *b*, pupa, back view; *c*, larva. Magnified.

Remedies.—These little pests can most successfully be destroyed by spraying with the arsenites early in spring when the buds are opening and the larvæ just beginning the season's work. It is advisable to use the Bordeaux mixture and Paris green combination in order to prevent injury by apple scab or other fungous maladies as well as insects.

FIG. 9. Bud Worm Moth.

The San José Scale

Aspidiotus perniciosus

This insect is related to the common oyster-shell bark-louse, but can at once be distinguished from the latter by the characteristic round scale—as shown at *b*, Fig. 10.

It infests practically all kinds of deciduous fruit trees and if unmolested is liable to kill them. It was introduced into California from Chili about 1870, since when it has spread over a large portion of the Pacific slope; and has lately appeared in the eastern states, where it threatens to do much damage.

Mr. L. O. Howard describes the San José Scale as "perfectly round, or at most very slightly elongated or irregular. It is flat, pressed close to the bark, resembles the bark of the

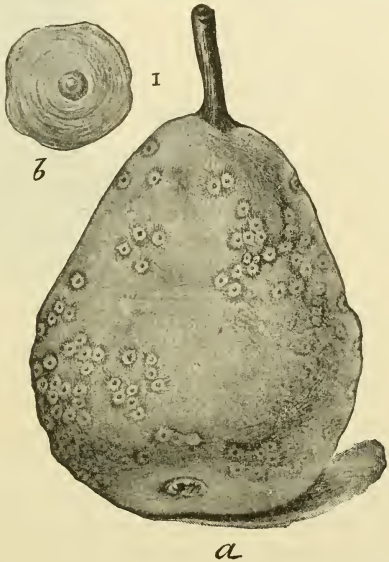

FIG. 10. San José Scale: *a*. pear, moderately infested—natural size; *b*, female scale—enlarged.

twigs in color, and when fully grown is about one-eighth of an inch in diameter. At or near the middle of each scale is a small, round, slightly elongated black point; or this point may sometimes appear yellowish. When occurring upon the bark of the twigs or leaves and in large numbers, the scales lie close to each other, frequently overlapping, and are at such times

difficult to distinguish without a magnifying glass. The general appearance which they present is of a grayish, very slightly roughened scurfy deposit. (Fig. 11.) The natural rich reddish color of the limbs of the peach and apple is quite obscured when these trees are thickly infested, and they have then every appearance of being coated with lime or ashes. When the scales are crushed by scraping, a yellowish oily liquid will appear, resulting from the crushing of the soft yellow insects beneath the scales, and this will at once indicate to one who is not familiar with their appearance the existence of healthy living scales on the trees."

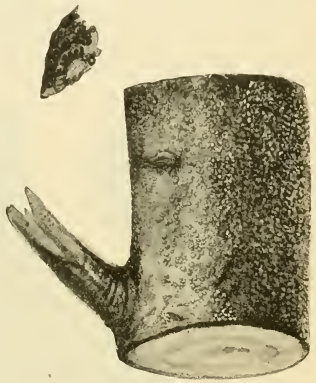

FIG. 11. San José Scale: Apple Branch, with scales in situ—natural size; enlarged scales above, at left.

The young scale lice hatch from eggs beneath the female scales, in spring, soon after the unfolding of the leaves. They are minute yellowish creatures, resembling Fig. 12 when highly magnified; they crawl about over the bark a short time, and finally fasten themselves to it, generally on the new growth, where they secrete a scale and there develop. Some of them mature into little two-winged creatures, resembling, when magnified, Fig. 14; these are the males: others develop into females, which do not become winged but remain on the bark in a fixed position. In the bodies of these the young are produced, as shown in Fig. 13.

When the San José scale occurs upon older trees, it is most likely to be found on the twigs and smaller limbs, but upon young trees it may occur over the whole surface. But it does not confine its attacks to the bark, for the leaves and fruit are often infested: upon the latter there is a very characteristic purplish ring around each scale. These rings are well illustrated in Fig. 10. "Upon the leaves the insects have a tendency

to collect along the midrib, on the upper side of the leaf, in one or more quite regular rows, and also to some extent along the side ribs. The infested leaves turn brown, but do not have a tendency to fall as a result of the damage."

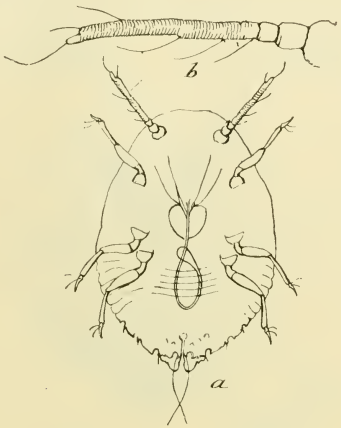

Fig. 12. San José Scale: *a*, young larva—greatly enlarged; *b*, antenna of same—still more enlarged.

This pest is most likely to be introduced into new localities upon nursery stock imported from infested regions. This is believed to be the way in which it was first brought to the Eastern states. It is also likely to be carried upon fruit sent to market. In a given locality the insects are most likely to be carried from tree to tree and orchard to orchard by the young lice crawling upon insects and birds and then crawling off after they have lit upon other trees. They may also be blown about by the wind.

The young lice are easily destroyed by spraying with kerosene emulsion. But in cases where the insect is first introduced to a new locality, the infested trees should be burned to check the outbreak.

Concerning this Mr. L. O. Howard, entomologist to the U. S. Department of Agriculture, says: "The principal mode of spread is by commerce in nursery stock, cuttings, and fruit. The time will come in the immediate future when some kind of quarantine regulations will have to be established by states, or by large fruit-growing districts. Should this species already

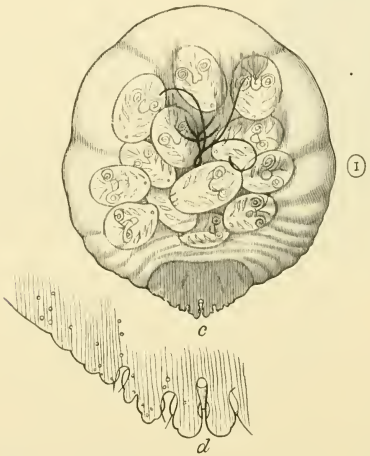

FIG. 13. San José Scale: *c*, adult female containing young—greatly enlarged; *d*, anal fringe of same—still more enlarged.

have obtained the firm foothold in the East which we suspect, New York, Michigan, and other states, in which the pomological interests are great, should immediately, by act of legislature, establish quarantine regulations similar to those in force at the present time in the state of California. In the meantime no orchardist should admit a single young fruit tree, or a single cutting, or a single bud, from a distance into his orchard, without first carefully examining it, and satisfying himself absolutely that

it does not carry a single specimen of the San José scale. If this plan is adopted by every one interested, and without exception, the rate of spread of the species can be limited to the natural spread by crawling, by winds, and by the aid of other insects and birds.

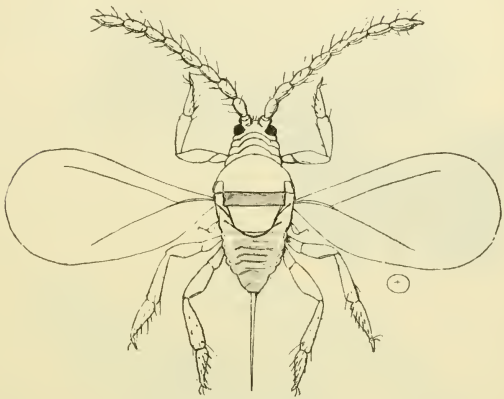

FIG. 14. San José Scale: male adult—greatly enlarged.

"We wish particularly to impress upon the minds of fruit-growers that as soon as this insect is found to occur in an orchard the most strenuous measures must be taken to stamp it out. No halfway measures will suffice. The individual must remember that not only are his own interests vitally at stake, but those of the entire community in which he resides. Trees badly infested should be instantly burned, as previously stated. The individual may think that he cannot bear the loss, but the loss in consequence of the slightest neglect will be much greater. The fact, too, that there is a community of interests among fruit-growers in this matter must not be lost sight of. Fruit-growers must be mutually helpful in an emergency like this."

The Gypsy Moth

Ocneria dispar

Fortunately this notorious insect, which our Massachusetts neighbors are striving hard to subdue, has not yet been found in New Hampshire. It is sincerely to be hoped that it may never be found here; but as we are so near the infested territory it seems worth while to include in this connection a brief notice of the pest.

The Gypsy moth is one of the most troublesome insects in Europe. It feeds on an extraordinary variety of plants, attacking almost everything, and is difficult to destroy by natural or artificial means. As is well known it was introduced into the vicinity of Boston twenty-five years ago, and has since become very destructive in that region. In 1891 the legislature of Massachusetts established a commission for the extermination of the insect, and has since appropriated a large amount of money to carry on the work, which has already checked the outbreak to a remarkable degree. It is much to be hoped that the work will be continued unabated for several years.

FIG. 15. Gypsy Moth. Male.

There is an idea somewhat prevalent that this insect could be exterminated by importing parasites, but this is fallacious. In my opinion it would be a great mistake to abandon the work of extermination and leave it to be done by parasites. Under the most favorable conditions there could only result a long series

FIG. 16. Gypsy Moth. Female.

of oscillations in the numbers of the moths, in which periods of destruction would alternate with periods of immunity.

The later stages of the Gypsy moth are illustrated in the accompanying figures. The male moths are much smaller than

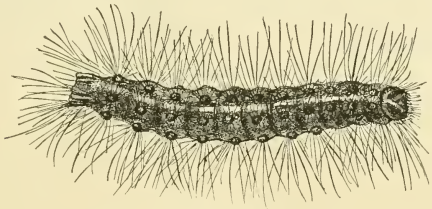

FIG. 17. Gypsy Moth Caterpillar.

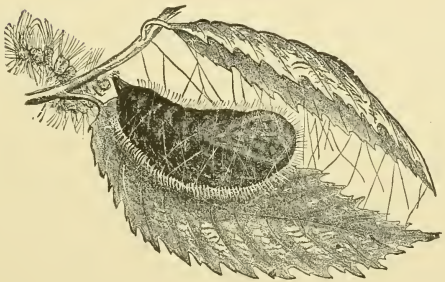

FIG. 18. Chrysalis of Gypsy Moth.

the females. "The full grown caterpillar is about an inch and three fourths in length, very dark brown or black, finely reticulated with pale yellow. There is a pale yellow line along the middle of the back and a similar one along each side. On the first six segments following the head there is a bluish tubercle, armed with several black spines on each side of the dorsal line, and on the remaining segments these tubercles are dark crimson red. In the middle of the tenth and eleventh segments there is a smaller red tubercle notched at the top. The whole surface

of the body is somewhat hairy, but along each side the hairs are long and form quite dense clusters." *

Should any one in New Hampshire find an insect answering to this description they would confer a favor by sending it, securely packed, to the writer. Information concerning the presence of any of the pests described in these pages would also be appreciated.

* Fernald.